# Environment quality monitoring using ARM processor

IOP Conf. Series: Materials Science and Engineering **263** (2017) 052020 doi:10.1088/1757-899X/263/5/052020

# Environment quality monitoring using ARM processor

**Vinaya C H, Vamsi Krishna Thanikanti and Sudha Ramasamy**

School of Electrical Engineering, VIT University, Vellore - 632014, Tamil Nadu, India.

E-mail: sudha.r@vit.ac.in

**Abstract**. This paper of air quality monitoring system describes a model of sensors network to continuously monitoring the environment with low cost developed model. At present time all over the world turned into a great revolution in industrial domain and on the other hand environment get polluting in a dangerous value. There are so many technologies present to reduce the polluting contents but still there is no completely reduction of that pollution. Even there are different methods to monitor the pollution content; these are much costly that not everyone can adapt those methods or devices. Now we are proposing a sensors connected network to monitor the environment continuously and displaying the pollutant gases percentage in air surroundings and can transmit the results to our mobiles by message. The advantage of this system is easy to design, establish at area to monitor, maintenance and most cost effective as well.

## 1. Introduction

All the countries in the world are developing economically by implementing different types of industries and designing automobiles. Because of these economical position of countries are increasing but on the other hand the pollutant gases releasing from those industries, automobiles are also increasing and effecting the environment very badly. Even there are so many technologies are implemented at industries to reduce those pollutant gases content like improving efficiency of equipment's and using low energy consumed equipment, less ash content products, etc. But still the pollution level is at dangerous only. There are so many methods to monitor the pollution contents, for this it required approximately 15000 airs sampling and monitoring devices and analyzing equipment. The different companies that manufacturing these devices are Foxboro Inc., BW technologies, Baldwin environment Inc., ACI instrumentation Ltd, Air metrics, others. Since these devices are monitoring and analyzing without any failures but still these systems are very costly and difficult to implement with low cost that can be available to all users even at home applications. The proposed system is going to be implemented within less cost and very easy to establish at working site and also monitoring and transmitting the resultant data to mobiles within seconds and also time to time monitoring continuously.

Main reason behind air pollution is, nowadays industrial development is much needed to any country to develop its economy and status but some industries using cheap equipment's to reduce the production cost. But with those cheap materials when they burnt or modulate for production, so many gases are released into environment. Low cost equipment's can decrease production cost but still they will release much smoke into atmosphere. That will contaminate the environment and create lot of illness and disability to the people [7][10-13].

Automobile industry is growing its capacity are increasing the market day by day. There are so many new models are coming into market even with low price. Everyone is easily affording those kinds of

automobiles. Due to increase in their usage, most harmful gases are releasing like carbon monoxide, smoke etc. which is released directly into environment also increasing the pollution. Due to all such reasons ozone layer getting damages and earth warming is becoming very high. So we are in need of monitoring the environment pollution. Knowing about the present air pollution data, it will help to predict the future value going to be occur and the solutions can take before it get occur to reduce the pollution effect. Air quality should be monitored continuously during the entire period to get the better results to avoid the lack of information about how much the pollution content is present at that area. Continuously monitoring will give the idea about the problem existing at present. Pollution or hazardous gases present in the air will influence the human health very seriously and it is necessary to reduce that. For reduction of such gases first we need to know the pollution content in the environment, for this the developed system will help us.

## 2. Methodology

### *2.1. MQ4 gas sensor*

MQ4 sensor is also a type of gas sensor that which is used to detect methane and also natural gas presence and leakage too [8][9]. MQ4 sensors are composed by ceramic tube, SnO2 layer. There all are crust and made by plastic and with stainless steel net layers. Every MQ4 sensor has 6 pins, where two of them used to provide heating current which supplies the entire architecture and remaining 4 used in signal fetching. The basic circuit of MQ4 sensor is shown in Figure 1. MQ4 is very different when compared with other gas sensors. Its sensitivity is very more and also it has to maintain when we use this sensor. For example to calibrate the MQ4 sensor to detect or measure 5000ppm methane gas in air, we have to use a load resistance of 20k**Ω** [3].

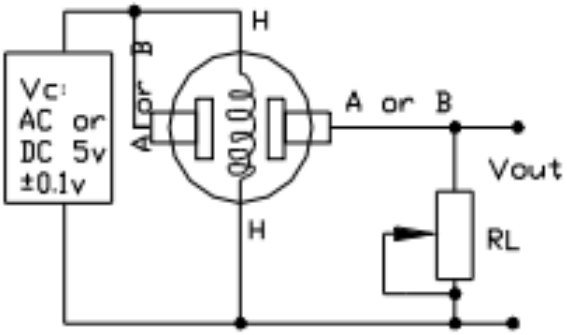


**Figure 1.** Test loop diagram of MQ4 sensor

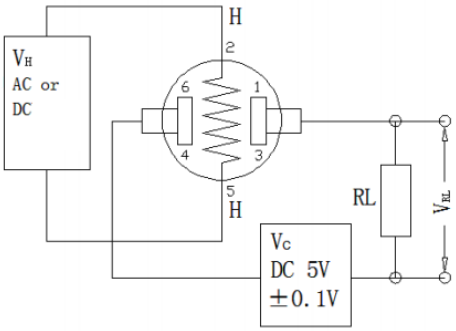


**Figure 2.** Basic test loop circuit of MQ7 sensor

### *2.2. MQ7 gas sensor*

MQ7 sensor is used to identify the presence of Carbon Monoxide content. It is used as CO detection equipment in family, car, industry [20]. MQ7 is made by microAL2O3 ceramic tube and Tin Dioxide sensitive layer. MQ7 has 6pin. 4pins are used for input signals and remaining 2 pins are used to provide heating current.[4]. Test loop circuit of MQ7 is shown in below Figure 2.

### *2.3. ARM processor*

ARM processor is one of the most powerful microprocessor that uses less power. It is a general purpose processor that having 32 bit microprocessor [6][14-19]. ARM processor is simple in design; flexible in operation makes it very useful in various applications. ARM processor have 32 bit RISC with high performance, 0.6mA/MHz at the rate of 3v in 0.8um low power consumption. The basic block diagram of ARM processor is as shown in Figure 3. When it comes to real time applications like air, water quality checking ARM processor is quick or fast response to variations, and having enough flash to store even a bulk programming. The block diagram consists of 2x16 characters LCD display

can display two lines at a time with 16 characters in each line. Every LCD has two registers. Data register stores the data that need to display and command register that can have commands like clear the LCD display, control and initializing the display before it get started. PS/2 port is used to connect keyboard, mouse and other computer ancillaries to processor. Audio amplifier is for using buzzers and other alarm to get a huge sound for alert. JTAG port is used to debug the code or program that need to implement into the processor.

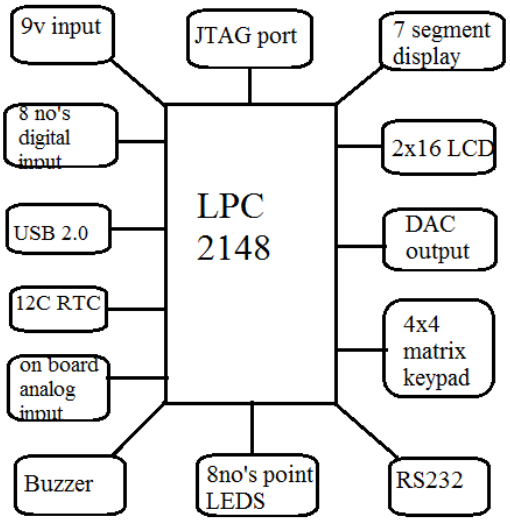


**Figure 3.** Block diagram of the Arm processor

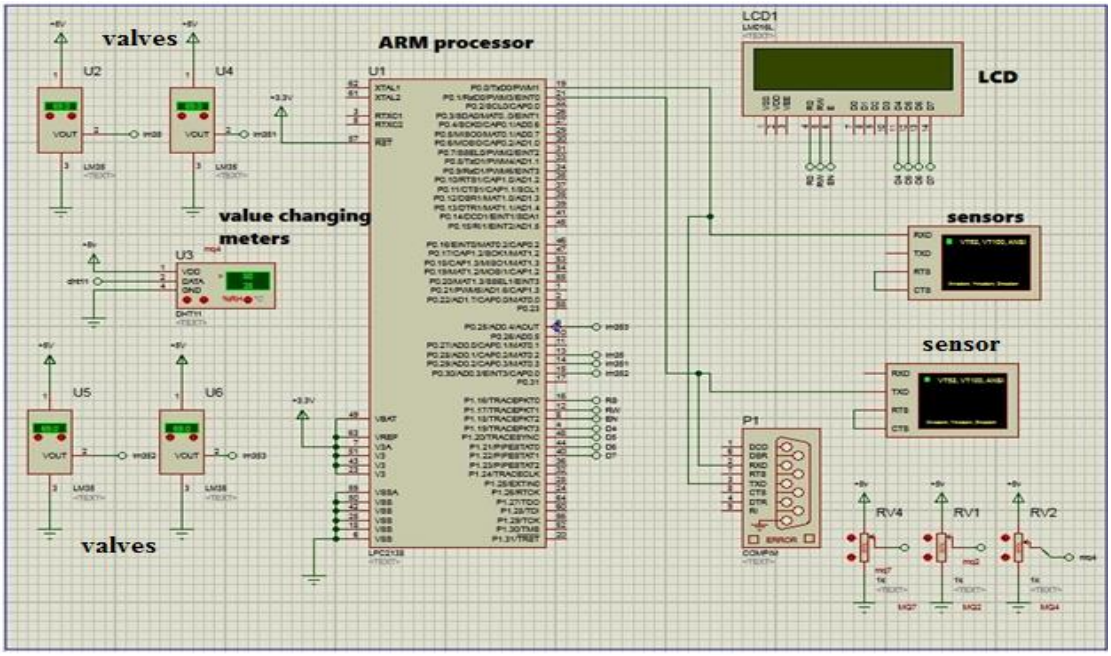


**Figure 4.** Simulation circuit of environment quality monitoring using ARM processor.

## 3. Experimental setup

Sensors which are used in the project MQ4 and MQ7 sensors are connected to ARM processor (Blue board LPC214X board). The entire sensor's analog output is connected to 12 and 13 pins of J1 of ARM processor. Vcc supply to both sensors is given to 6$^{th}$ pin of J1 and

J2 of ARM processor. Any sensor can connect to those pins. And the final ground pins of two sensors connected to 5th pin of J1 and 1st pin of J2 of ARM processor. Respective connections discussed before are shown in below simulation diagram. The working principle of above setup is when where this setup to exposed to air, the sensors are capable of measure the quantities of carbon monoxide and methane content in air surrounding to them and they will display the value that measured by them on LCD panel. In simulation it is possible to check whether the sensors are displaying the changes done in those gases values by varying them with value changing meters. Figure 4 shows the simulation circuit and Figure 5 shows the experimental setup of hardware circuit which is implemented. Two sensors MQ4, MQ7 are connected to the ARM processor and the setup displaying the both Carbon monoxide and Methane content in the air around the setup.

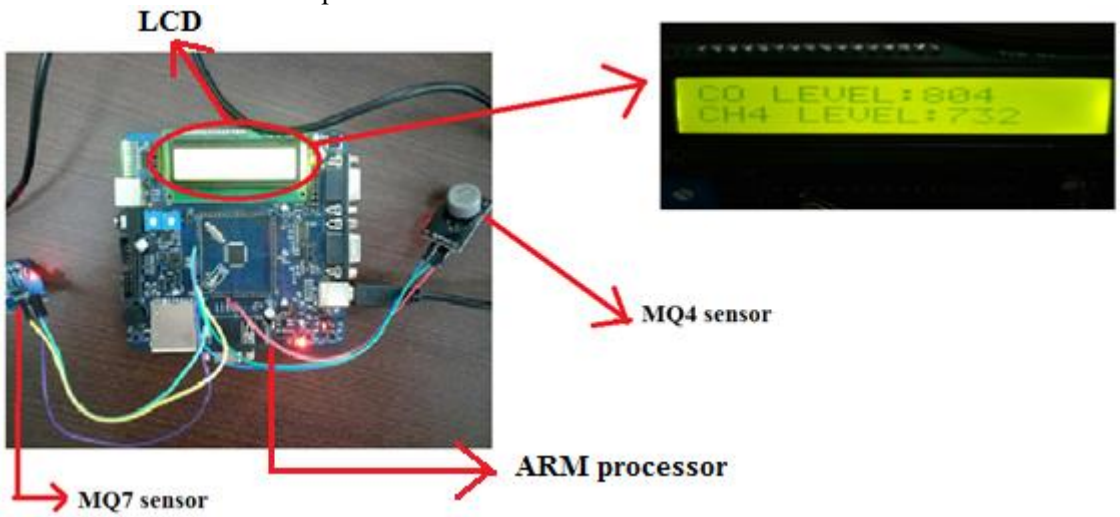


**Figure 5.** Hardware setup of environment monitoring system

## 4. Result

The proposed hardware setup was successfully measured the gases and displaying on LCD screen. All gas sensors are perfectly operating with ARM processor. There is a lot of future scope for this type of sensor connected system that can use not only for air quality monitoring but also water quality checking with proper protection. It is very simple, low cost system that can easily place at industries, smart buildings and smart home also. More sensors connected to that system will give the information about each quantity that we want to measure. The proposed system can be widely used for measuring the gases like carbon di oxide, methane in water, air, soil, any quantity with respective sensors to measure them. Irrespective of ARM processor we can also implement using different processors like 8051 microcontroller, raspberry pi and arduino board. This system can be implemented for a long term use with proper care and monitor. Also improve the data acquisition and processing the data by using the IoT environment. It is Easy to implement, easy to monitor without any harm, user friendly, and easy to extend its application just by adding sensor to existing system.

## References

[1] Prajapati C S, R Soman, S B Rudraswamy, M Nayak and N Bhat 2017 *J. Microelectromech. Syst.* **26** 433-439
[2] Chi Q, H Yan, C Zhang, Z Pang and L D Xu 2014 *IEEE Trans. Ind. Informat.***10** 1417-1425
[3] https://www.sparkfun.com/datasheets/Sensors/Biometric/MQ-4.pdf
[4] https://www.sparkfun.com/datasheets/Sensors/Biometric/MQ-7.pdf
[5] https://www.pantechsolutions.net/microcontroller-tutorials/user-manual-arm7-lpc2148-

development-kit
[6] Hongjiang H and W Shuangyou 2008 The Application of ARM and ZigBee Technology Wireless Networks in Monitoring Mine Safety System *ISECS International Colloquium on Computing, Communication, Control, and Management* Guangzhou 430-433
[7] Marinov M B, I Topalov, E Gieva and G Nikolov 2016 Air quality monitoring in urban environments *39th International Spring Seminar on Electronics Technology (ISSE)* Pilsen 443-448
[8] Julius T. Sese, Joseph Bryan G Ibarra, Kathlia De Castro-Cruz 2016 Effects of different adsorbent on methane reduction on a garbage bin using MQ4 Gas Sensor *6th IEEE International Conference on Control System, Computing and Engineering (ICCSCE),* BatuFerringhi 455-459
[9] Lei Shu, Mithun Mukherjee, and Xiaoling Wu 2016 *IEEE Trans. Commun.* **54** 22-28
[10] Giorgi G 2015 *IEEE Sensors Journal* **15** 2488-2496
[11] Brzoza-Woch R, M Konieczny, P Nawrocki, T Szydlo and K Zielinski 2016 Embedded systems in the application of fog computing — Levee monitoring use case *11th IEEE Symposium on Industrial Embedded Systems (SIES),* Krakow 1-6
[12] Neto L, J Reis, R Silva and G Gonçalves 2017 Sensor SelComp, a smart component for the industrial sensor cloud of the future *IEEE International Conference on Industrial Technology (ICIT)* Toronto, ON 1256-1261
[13] Jiawen Wang, Hairong Yan, YueXie and Zhibo Pang 2016 Research and implementation of groups positioning method for wireless sensor networking, *IEEE 25th International Symposium on Industrial Electronics (ISIE)*, Santa Clara, CA, 1174-1179
[14] Sirajum Munir, Ripudaman Singh Arora, Craig Hesling, Juncheng Li, Jonathan Francis, Charles Shelton, Christopher Martin, Anthony Rowe and Mario Berges 2017 Real-Time Fine Grained Occupancy Estimation Using Depth Sensors on ARM Embedded Platforms *IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)* Pittsburg USA 295-306
[15] Bull D, S Das, K Shivashankar, G S Dasika, K Flautner and D Blaauw 2011 *IEEE Journal of Solid-State Circuits* **46** 18-31
[16] Chang C C, Y H Shih and P M Wang 2016 Design and implement SPEEX decoder on ARM processor *9th International Congress on Image and Signal Processing, Biomedical Engineering and Informatics (CISP-BMEI)* Datong 920-924
[17] Luo F, C Gu, B Yan, C Fan and S Huang 2015 Simulation to ARM Processors Based on the Instruction's Eigenvalue *IEEE 17th International Conference on High Performance Computing and Communications*, NewYork,NY 1579-1584
[18] Ali S, A Sardar, K K Patra and R Barua 2015 Development of low cost portable ARM processor based GCS data interface module for range sensors network, *International Conference on Microwave, Optical and Communication Engineering (ICMOCE),* Bhubaneswar 76-79
[19] Chaure R and N A Pande 2016 Design and implementation of Ethernet based embedded network controller using ARM7 (LPC2148) processor *World Conference on Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave),* Coimbatore 1-4
[20] Nugroho R B, E Susanto and U Sunarya 2014 Wireless sensor network for prototype of fire detection, *2nd International Conference on Information and Communication Technology (ICoICT),* Bandung 469-474